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MODERN METHODS TO SECURE RELIABLE BASIC DATA FOR PLANNING OF WATER RESOURCES DEVELOPMENT

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Modern methods to secure reliable basic data for planning of water resources development

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1. Design of Hydrometeorological Networks .

(a) The Need for Hydrologic and Meteorologic Data.

(i) The collection of adequate reliable hydrologic and meteorologic data in a standardized manner is the first requirement of orderly planning for hydraulic development projects. There is no substitute for reliable basic data. The costs for data collection and processing are always small as compared to total project costs.

(ii) Basic data required for water resources development include:

streamflow and river and lake stage, which are the most important data and basic to the solution of most hydrological design and operation problems,

precipitation and snowpack, which are mainly needed to supplement and check streamflow data, but also used in storm frequency analysis and water balance computations,

evaporation, which is used in determining water losses from reservoirs and in computing the water balance of a drainage basin or region,

sediment transport and deposition, which are useful in the design of reservoirs, canals and other hydraulic structures.

(b) Existing Hydrologic and Meteorologic records.

(i) An inventory of all hydrologic records available from existing and abandoned observation stations should be prepared prior to planning a network. A critical review of this could sometimes save money, which otherwise could have been spent to obtain data, which

were already collected. The Weather Service usually employs a number of rainfall stations and in areas where the water resources already are utilized in some way for power production, irrigation etc. there are generally some hydrologic records in the files, which can prove to be useful.

(ii) It should also be thoroughly investigated how much hydrologic information can be obtained from neighboring countries: not only streamflow data for rivers flowing to or from the neighboring country but also rainfall and evaporation data from border areas can be extremely helpful.

(c) Modern Principles for Hydrometeorological Network Planning.

(i) A proper hydrometeorological network plan should provide a program through which a maximum amount of reliable information could be obtained for the most reasonable cost. It is beleived impractical to employ "universal" formulaes and rules for the network density. The special meteorologic, climatologic, hydrologic and physiographic conditions in the area concerned should be the guide. Also the relative importance of the rivers for different purposes should be considered.

In designing the network use should be made of modern methods of network planning. The streamflow in a river is generally related to the flow in adjecent rivers within the same climatic and topographic region. So flow data in one river can be used as an index of the flow in nearby watercourses. The same is also true for rainfall and evaporation data. Thus it is possible to correlate the measured streamflow, rainfall etc. in one place with the corresponding data in another nearby place - quite apart from the relations between the flow in a main stream and the same of the flows in converging tributaries. There are also well-known relations between runoff and rainfall.

If these inter-relations are considered the number of stations could be kept at a minimum. Furthermore the stations should be divided into permanently operated base stations and temporarily operated secondary stations. The base stations are to be operated for an indefinite period of time and they will serve as fixed points for the time sampling factor. The secondary stations are operated to provide geographic sampling. The secondary stations should not be

operated any longer than required to establish a good correlation to a nearby base station. Five years are generally considered sufficient. At the end of that period the station and the equipment should be moved to some other location.

If the location of the secondary stations are carefully determined in relation to the network of base stations and the period of observation chosen in relation to the accuracy needed in the correlation, it will in most cases produce results sufficiently accurate for all practical purposes, provided the correlation is made with engineering criteria, considering the major factors differentiating the watersheds.

The base stations should be evenly distributed over country with due regard to different climatic and topographic regions and the locations should be carefully selected. The secondary stations, which should form a network inbetween the base stations, could be located in a less critical manner.

It is important in this kind of network plan not to operate the secondary stations too long. Maximum information is gained if they are moved to new localities after proper intervals of time.

In addition to these stations (base and secondary), which give the general information on the areal and time distribution of streamflow, rainfall and evaporation, a number of stations could be established for special purposes. These project stations could be permanent, such as those needed for the operation of power plants or irrigation systems, or temporary, such as stations for flood studies.

It is also important not to include too many stations in the ordinary network of base and secondary stations. If in some densly populated areas the stations are closer than needed in the general network plan, they should be abandoned. Then there is no reason to waste money on them.

A sediment station should always be combined with a streamflow station, but sediment stations are not always needed at every streamflow station. The local condition should govern the relative density of the network for streamflow and sediment measurements.

An evaporation station should always be combined with a rainfall station, but as the evaporation does not vary so much from place to place as the rainfall it is generally sufficient to have evaporation measurement just at every tenth or twentieth rainfall station.

(ii) Because of the inter-relations between rainfall and streamflow (runoff) the rainfall and streamflow networks should be closely co-ordinated.

There are usually many different agencies concerned with the hydrology of a country. Each of them often want just a special kind of information. And if these different agencies employ their own hydrometeorological stations the records can usually not be used by other agencies. For instance in flood studies only peak flows and high stages are observed, which are of little interest in ground water studies and at power plants the floods usually pass ungaged etc.

Thus in planning a hydrometeorological network it is extremely important to unify the different interests. A joint commission should be formed for the planning work. Representatives from the Weather Service should join the commission.

One sole agency should establish and operate the stations. Only in this way could the observation methods be standardized and kept available to all agencies interested. This agency could also train the staff needed.

The only exception to this is the Weather Service which should operate their own stations and file the records. There the observations are usually performed according to internationally recognized standards.

In planning the network due regard should be taken to existing and planned stations in neighboring countries.

International cooperation across the borders in the form of exchange of hydrometeorological data and utilization of results of hydrological studies should be provided for.

(iii) In the network plan there should be stated an order of priority. Highest priority should be given to existing streamflow stations selected as base stations. They should be improved if necessary. Next in priority come the proposed new base streamflow stations.

Only when the network of base streamflow stations is established the secondary streamflow station should be established. The establishment of rainfall station should be of lower priority than the streamflow stations.

2. Some Techniques for Estimating Hydrological Data

In the absence of adequate basic hydrometeorological data astonishing good results can be obtained through comparatively simple methods by using the inter-relations between rainfall and runoff, provided the computations are made with engineering nicety. The accuracy - or lack of accuracy - of the observed data must always be taken into consideration.

(a) One of the most useful methods is based on the index-concept. - An example: the gaged amount of rainfall during a number of storms is an index of the peak flow. A simple plotting in a diagram of corresponding values often reveals a useful relationship.

In the same simple way relations could be obtained between the stream-flow in adjacent rivers.

(b) In water balance studies use should be made of the difference between rainfall and runoff, which equals evaporation for longer periods, rather than runoff coefficients, which depend upon the amount of rainfall.

The evaporation could be computed from Thornthwaite's formula.

(c) In flood frequency studies deliborate frequency formulas are often used to compute the propability of floods.

The same accuracy in the estimate could easily be obtained by simple plotting the accumulated frequencies on a probability paper and extra-polating the curve.

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